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dicates a line of communication, intercourse, traffic, and possibly migration by the way of the Gulf of California and the Colorado River. If the Olivella is *O. biplicata*, and the beads, which it is said are as thin as a wafer and of the circumference of an ordinary pea, are what I suspect,[1] then we have a right to infer that these interior people were in communication directly or indirectly with the California tribes north of what is now known as Lower California. If any of the shell ornaments are made of some species of *Busycon*, then communication with the Gulf of Mexico is implied.

If all of the shells cited by Mr. Barber, and involved in doubt by the indefiniteness of his paper, are actually represented in the material collected, then the whole question as to the origin, distribution, and characteristics of the extinct tribes of Colorado, Utah, and Arizona is still further complicated, for it indicates intercourse, traffic, and perhaps migration in three directions, and the relations of these interior people with the maritime or coast tribes of both sides of the continent, or through, or with intermediate, tribes, become a factor which has to be duly weighed and considered, the importance of which is only equaled by its complexity.

It is highly probable that an examination of the shell ornaments mentioned by Mr. Barber by some competent conchologist familiar with West American shells and with the ethnological material of the California mounds would authenticate the species of which Mr. Barber's shell ornaments are made, and it is to be hoped that he will have them carefully examined, and state not only the species but the authority for their determination. By doing so he will add much to the value of his researches, and the object of this criticism will be accomplished.

THE LONG-JAWED GOBY.

BY W. N. LOCKINGTON.

THE somewhat inelegant title I have given to this curious little fish cannot be said to be its vernacular name, since, like the greater portion of the creatures that inhabit the world, it has not as yet acquired a commonly received name in our language, and the only name it has a perfect right to is the Latin one bestowed by its first describer, Dr. J. G. Cooper, namely, *Gillichthys mirabilis*.

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[1] Similar beads are found in the California mounds, and are simple concavo-convex disks cut out of the body whorl of *O. biplicata*.

As *Gillichthys* is simply a compound of the name of a celebrated American icthyologist with the Greek word for a fish, and *mirabilis* means nothing more than "wonderful" or "curious," this Latin name gives no idea of the fish, so it will be as well to call it the long-jawed goby, as its chief peculiarity consists in its tremendous length of jaw.

A garpike has a long jaw, and so has an alligator, and it is not unlikely that the title will call up in the minds of some who read this the idea of a terrible mouth, armed with bristling rows of teeth. This would be a great mistake, for our little fish has no teeth worth bragging about, and does not open his mouth any wider than a well-behaved fish should do. The great difference between his long jaws and those of a garpike is that the latter's project forwards, while those of our goby are prolonged backwards immensely.

The long-jawed goby was discovered by Dr. Cooper in the bay of San Diego, among seaweed growing on small stones at the wharf, and in such a position that it must have been out of water from three to six hours daily, though kept moist by the seaweed.

Dr. Cooper's two specimens held their place as curiosities among the *olla podrida* of the Museum of the California Academy of Sciences for several years, no one suspecting that the fish was a resident of the neighborhood of San Francisco, as no specimens were ever found in the fish-market.

A few months ago two specimens were brought to the Academy by one of its members, who stated that he had obtained them from some Chinamen who lived on the marshes near the mouth of San Antonio Creek, Oakland; that they were found by digging in the mud beside the brackish creeks that intersect the marshes, and that the Chinamen eat them, and find them good.

These specimens were not so large as those presented by Dr. Cooper, and differed from them in the much smaller proportionate length and width of the singular cartilaginous expansion of the maxillary bone, which, uniting with a membrane from the lower jaw, continues backwards as a long fold or pouch as far as, or even beyond, the gill-covers, and gives to the fish its unique appearance.

On a more recent occasion a single *Gillichthys*, much larger than any of those before mentioned, was presented by a gentleman, who said that the fish, which was new to him, was abundant upon his ranch in Richardson's Bay, in the northern part of the bay of San Francisco; that the Chinamen dug them up and ate them, and that he had had about eleven specimens cooked, and found them good, tasting, he thought, something like eels, the twelfth specimen he had preserved in alcohol, in the interest of natural science. This gentleman had the opportunity of observing something of the mode of life of these fishes, and informed us that their holes, excavated in the muddy banks of tidal creeks, increase in size as they go downwards, so that the lower portion is below the water level, or at least sufficiently low to be kept wet by the percolation from the surrounding mud.

When the various specimens now acquired were placed side by side, the difference in the relative length of their jaws was very conspicuous, for while in the smallest it was about one-fifth of the total length, in the largest it exceeded one-third.

As the fish had now been found in two places in the bay, I thought I would try to find it also, and to this end sallied out one morning, armed with a spade, and commenced prospecting in a marsh at Berkeley, not very far from the State University. For a long time I was unsuccessful, as I did not know by what outward signs their habitations could be distinguished, and the extent of mud-bank left bare by the retreating tide, was, as compared with my powers of delving, practically limitless.

At last, toward evening, while digging in the bend of a small creek, in a stratum of soft, bluish mud, and at a depth of about a foot below a small puddle, I found five small fishes, which at first I believed to belong to an undescribed species, so little did they resemble the typical *G. mirabilis*, but which proved, upon a closer examination, to be the young of that species. There was the depressed, broad head, the funnel-shaped ventral "disk" formed by the union of the two ventral fins, and the compressed tail of the long-jawed goby, but where were the long jaws? The jaws were, of course, in their usual place, but their prolongations had only just commenced to grow along the sides of the head, and were not noticeable unless looked for. A comparison of the various specimens proved conclusively that the strange-looking appendage is developed during the growth of the fish, as will be seen by the following measurements of four individuals: —

	No. 1.	No 2.	No. 3.	No. 4.
Total length	65 mm.	98 mm.	132 mm.	165 mm.
From tip of snout to end of maxillary expansion, measured along curve to centre line of jaw.	11 mm.	20 mm.	40 mm.	56 mm.

In the smallest specimen the maxillary expansion extends beyond the orbit for a distance about equal to that which intervenes between the anterior margin of the orbit and the tip of the snout; in No. 2 it reaches to the posterior margin of the preoperculum; in No. 3 it ends level with the gill-opening; while in the largest individual it passes the origin of the pectoral and ventral fins.

What can be the use of this long fold of skin and cartilage, which is not attached to the head except where it joins the mouth; and which from its gradual development and ultimate large dimensions, must certainly serve some useful purpose?

Do not understand that I mean that every part of a creature is of use to it in its present mode of life, for as all naturalists know, there are in structural anatomy, just as in social life, cases of *survival;* remains of organs which were at some former time more developed, parallel in their nature to such survivals in costume, as the two buttons on the back of a man's coat, once useful for the attachment of a sword-belt. But in this fish we have no case of survival, but one of unusual development; the family (Gobiidæ) to which it belongs presents no similar case, although its members have somewhat similar habits, and the conviction grows upon us, as we consider the subject, that the long jaws serve some useful purpose in the economy of the creature. In view of the half-terrestrial life led by this fish, I am inclined to suspect that the expansion of the upper jaw may serve for the retention of a small quantity of water, which, slowly trickling downward into the mouth and gills, keeps the latter moist when, from an unusually low tide or a dry season, the waters of its native creek fail, perhaps for several hours, to reach the holes in which the fishes dwell. It may be objected to this view that, were such an appendage necessary, or even useful, other species of Gobiidæ, whose habits are similar, would show traces of a similar adaptation. This, however, by no means follows. Nature has many ways of working out the same end; and it must be remembered that every real species when thoroughly known differs somewhat in habits from its congeners, or at least from its family friends. To take an illustration from the mammalia. The chimpanzee and the spider-monkey are both quadrumanous and both arboreal, yet the end which is attained in the former by its more perfect hands is reached in the latter by its prehensile tail.

There are many fishes which can resist a tolerably long desiccation, but the means by which they are enabled to do this vary greatly. The Ophiocephalidæ, a small family of fresh-water fishes found in the East Indies, have a cavity capable of containing water situated inside the head, and accessory to the gill-cavity; the *Labyrinthici*, of which the *Anabas scandens*, or climbing perch, is a well-known example, have an organ composed of thin laminæ, and well suited to contain water, situated in a cavity over the gills, and the gill-opening is narrow; the cuchia (*Amphipurus cuchia*) of Bengal is provided with a sac for the reception of air, and has rudimentary branchiæ, while the three curious fishes forming the sub-class Dipnoi, the Protopterus of West Africa, the Lepidosiren of the Amazon and its tributaries, and the Ceratodus of the rivers of Queensland, Australia, are all provided with a lung-like air-bladder, and have narrow gill-openings and fewer gills than ordinary fishes.

All the fishes mentioned above can bear deprivation of water for more or less time; the Ophiocephalidæ and the cuchia take overland journeys in search of water; the Labyrinthici take some of their prey out of water, are said to be able to ascend trees, and can live for some time in dried mud; and the Protopterus remains alive for many months encased in lumps of the dried mud of the river bed, awaiting only the rainy season to resume its predatory life.

Why may not the extremely long channel formed by the jaw of this rather abnormal member of the goby family be another mode of provision for the requirements of respiration?

The two ordinary gobies (*Gobius lepidus* and *G. Newberryi*), which are found in San Francisco water, although they reside in cavities in the mud or sand, need no such protection as the Gillichthys, since the latter inhabits the tidal sand and mud flats of the sea beach, at such a depth below the surface that it can never be short of water while uncovered by the tide; while the former has not, within my knowledge at least, been found in localities left bare by the tides.

Of the geographical range of the long-jawed goby, to the north of San Francisco, I know nothing, but it extends southward at least as far as the Gulf of California, since I found a single young specimen of it among miscellanea collected there by Mr. W. J. Fisher.

This individual differs from those obtained in the bay of San Francisco in the decidedly reddish tint of the under surface (a slaty gray is the usual color), but this is probably at most only a local peculiarity, as I can detect no other difference.